

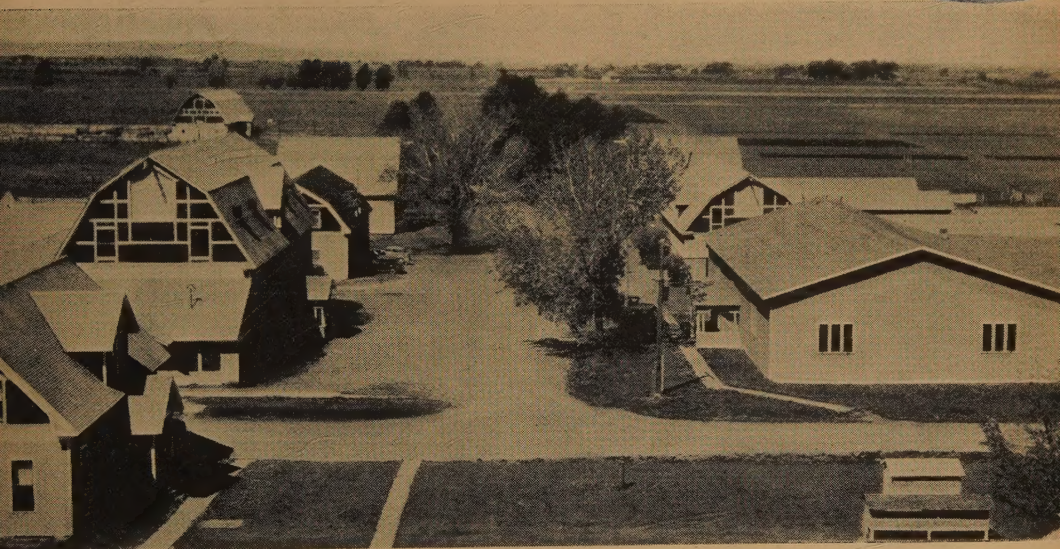
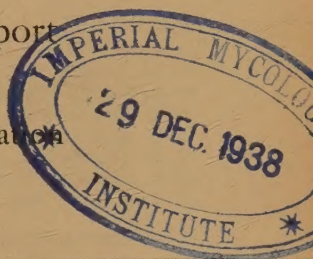
Service to Montana's Livestock Industry

The Forty-Second Annual Report

of the

Montana Agricultural Experiment Station

July 1, 1934, to June 30, 1935



LIVESTOCK BUILDINGS AT THE EXPERIMENT STATION

MONTANA STATE COLLEGE
AGRICULTURAL EXPERIMENT STATION
BOZEMAN, MONTANA

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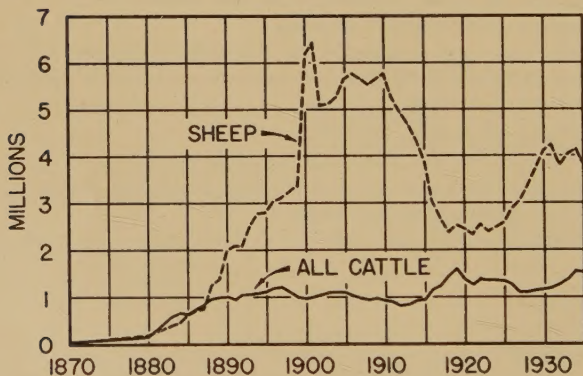
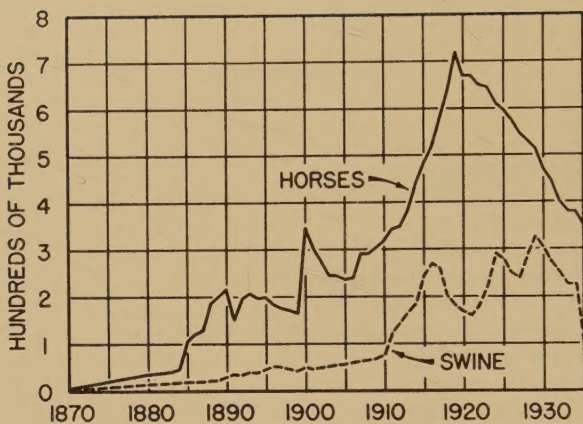
¹Organization as of November 30, 1935.

²On leave of absence.

³Cooperating with the United States Department of Agriculture.

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TREND IN NUMBERS OF LIVESTOCK IN MONTANA
FROM 1870 TO 1930

Service to Montana's Livestock Industry

Montana has always been a livestock state. To the Indian it was a happy hunting ground with immense herds of buffalo, elk, deer, and antelope. In the mountain areas of the west were numerous bighorn sheep and Rocky Mountain goats. By the middle 80's the white man with his rifle had practically exterminated the buffalo, while the elk and deer were largely driven back to the mountainous and timbered areas of the state. A few years later only a few scattered bands remained of the many herds of antelope which roamed over the plains area.

In the late 70's cattle were moving into the state and gradually took over the buffalo range. Many Longhorns were driven across the country from Texas to be grown out in Montana and sold fat from grass at four and five years of age. Other cattle were brought from Utah and Oregon and some from states to the east. The cattle industry dominated the agriculture of the state from 1880 to the early years of the present century. During this same period sheep were brought into the state. The early flocks contained many wethers, as wool was the important market product. During the past thirty years, as the lambs contributed an increasing part of the income, a transfer has been made to the ewe flock.

In the early days of the cattle industry there was little owned land. There were a few fenced areas—around the home ranch and around springs—to protect and control the water supply. In some districts fences were built around large areas and the land was selected and leased, inclosing extensive tracts of range land. However, soon after the beginning of the present century, the United States Government made a ruling that public domain could not be fenced but must be kept open to all users.

The forest areas, which contained much good pasture land, were first set apart as forest reserves in 1901.* They were enlarged and increased in number through succeeding years, and the pasture within these areas was made available to stockmen.

*Designated as national forest in 1907.

Certain regulations were enforced and fees were collected for pasturing livestock on the reserves. While this introduced a new factor in range use it was an aid in safeguarding the industry as the pasture area allotted could be depended on for a number of years.

Livestock statistics for Montana have been gathered by the United States Department of Agriculture since 1870. Table 1 gives in 5-year averages the number of the various classes of livestock up to 1935. For the last 5-year period the numbers are also given for each year, 1931 to 1935, inclusive. In the earlier

TABLE 1.—ESTIMATED CLASSIFICATION OF MONTANA LIVESTOCK AS OF JANUARY 1, 1870 TO 1935

Year	Milk cattle	Other cattle	All cattle	Horses	Sheep	Swine	Mules
1870	12,400	24,000	36,400	5,300	2,000	2,600	500
1880	11,500	162,000	173,500	36,000	18,500	10,500	900
1885	23,000	615,000	638,000	105,000	625,000	19,000	2,800
1886-90	29,140	883,460	913,400	170,520	1,224,000	22,600	6,260
1891-95	36,300	1,025,920	1,062,240	190,200	2,459,200	38,800	1,200
1896-00	44,040	1,058,500	1,102,400	208,200	3,796,000	48,460	1,300
1901-05	52,140	1,022,760	1,074,900	260,880	5,505,400	52,020	3,400
1906-10	70,320	901,460	970,780	289,200	5,658,800	66,360	4,320
1911-15	96,800	792,400	889,200	400,800	4,404,200	173,800	5,500
1916-20	151,200	1,219,600	1,372,800	625,800	2,610,000	215,800	8,200
1921-25	236,400	1,143,800	1,341,800	633,800	2,471,200	227,400	10,200
1926-30	205,300	959,200	1,164,800	527,600	3,443,600	281,600	11,000
1931	193,000	1,070,000	1,263,000	430,000	4,244,000	280,000	9,000
1932	195,000	1,081,000	1,276,000	400,000	3,820,000	252,000	8,000
1933	195,000	1,183,000	1,378,000	380,000	4,049,000	227,000	8,000
1934	211,000	1,332,000	1,543,000	380,000	4,144,000	227,000	8,000
1935	194,000	1,436,000	1,530,000	352,000	3,823,000	98,370	8,000
1931-35	197,600	1,220,400	1,398,000	388,400	4,016,000	236,874	8,200

years the numbers given are only approximate but for later years they are fairly dependable.

The fluctuations in these numbers during the years are interesting. Cattle of all kinds decreased after 1905 due probably to the coming of the homesteader and the fencing of the range area. The number increased to the earlier record by the period 1916 to 1920, but a large part of this increase was in milk cows on farms. For the period 1931 to 1935, however, the large increase was in range cattle. During this period the number climbed to an all time record.

Until the beginning of the present century wethers made up a considerable part of the sheep of the state. Since that time the flocks have been changed to a ewe and lamb basis. Sheep numbers held up fairly well until the years 1911 to 1915, but dropped off for the 10-year period from 1916 to 1925, after which they again increased but not quite to the maximum number of 20 years before. Lambs under 8 months are not included in these numbers. With the increase in farms came an increase in horses and mules and also an increase in hogs. These have decreased in number during the past 10 years.

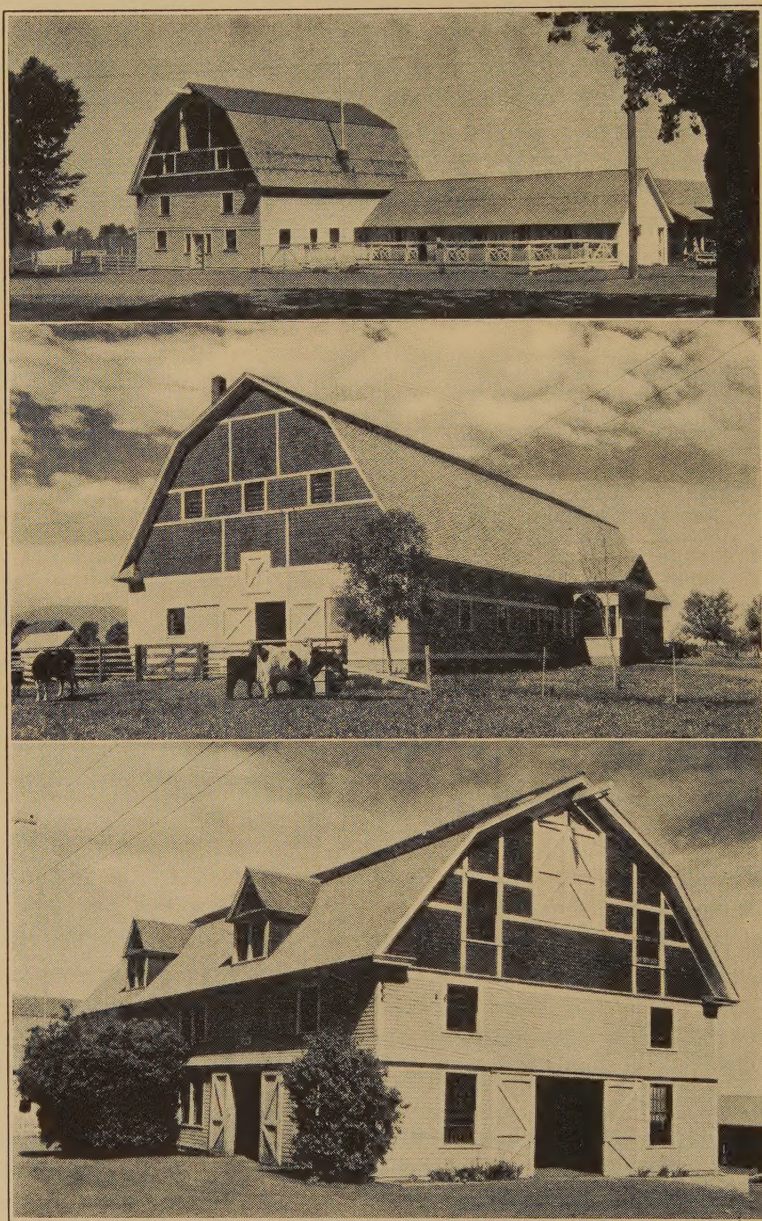
TABLE 2.—CATTLE SHIPMENTS FROM MONTANA

Year	Number
1885	79,089
1886-90	133,454
1891-95	248,255
1896-00	220,561
1901-05	229,860
1906-10	244,505
1911-15	198,881
1916-20	363,976
1921-25	292,794
1926-30	340,400
1931	310,000
1932	215,000
1933	210,990
1934	537,270
1935	570,240
1931-35	368,700

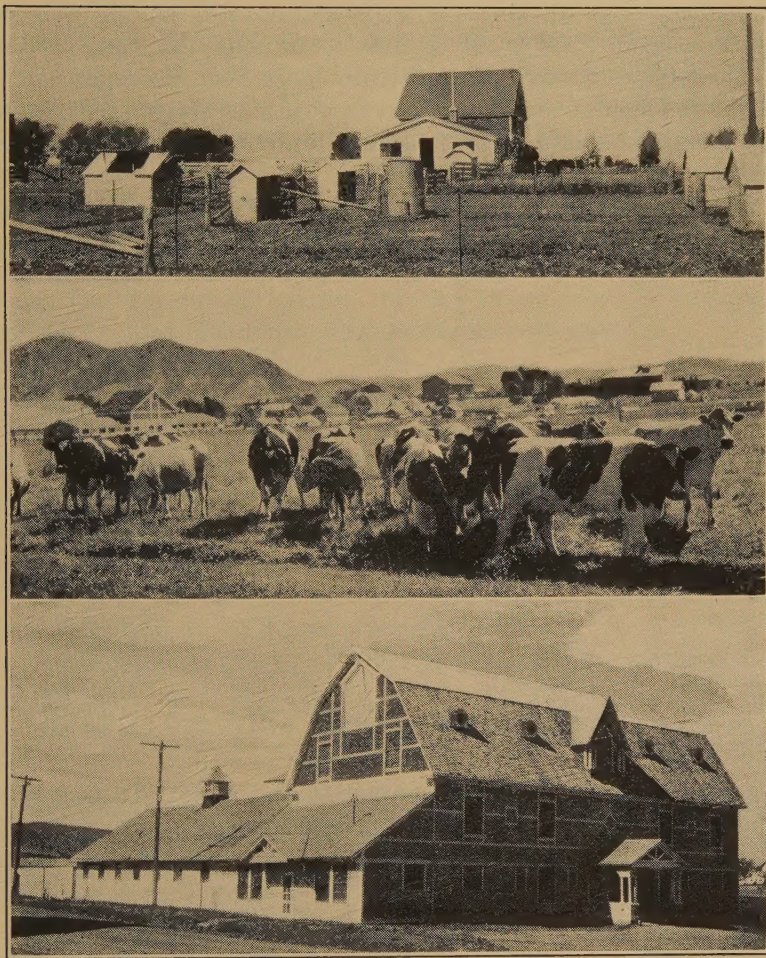
Note.—The figures for the past three years are calculated from monthly carlot shipments as reported by the Montana Railroad Commission. The carlot shipments have been multiplied by 30 to get the total number of head.

Rather accurate records have been kept of cattle shipments out of the state since 1885 (see table 2). On the average for 5-year periods, annual shipments did not exceed 250,000 head until 1916 to 1920. Since that time the average shipments have been nearly 300,000 head or over. In the 5-year period 1931 to 1935 more cattle were shipped out annually than in any previous period. The shipments because of drought were a factor in this large increase.

Wool production showed a very large increase to 1905 (see table 3). The largest 5-year average yearly production in the history of the state was during the period 1901 to 1905. A close second occurred during the 5 years 1931 to 1935. As the sheep at this later date were less in number, the average fleece weights



EXPERIMENT STATION AT BOZEMAN. ABOVE, SHEEP BARN;
CENTER, BEEF CATTLE BARN; BELOW, HORSE BARN



EXPERIMENT STATION AT BOZEMAN. ABOVE, HOG BUILDINGS AND YARDS; CENTER, DAIRY HERD; BELOW, DAIRY BARN

must have been considerably greater. Montana wool ranks high in quality among that produced in western states.

The farmers who came to Montana in the latter part of the last century took up land in the mountain valleys and along the river bottoms. They built ditches to irrigate this land. Gradually through the years these ditches have been enlarged and extended and others added to increase the irrigated area. These early irrigated tracts were to a large extent adjunct to the range livestock industry.

With the beginning of the century the farm settlers started to move onto the dry land of the state, due largely to the propaganda on dry land farming and its possibilities. This, in a few

TABLE 3.—MONTANA WOOL PRODUCTION

Year	Average pounds per year
1880	1,000,000
1886-90	8,495,750
1891-95	16,902,400
1896-00	23,806,600
1901-05	34,438,800
1906-10	33,487,000
1911-15	30,935,400
1916-20	20,332,800
1921-25	19,001,600
1926-30	27,912,200
1931	38,313,000
1932	32,300,000
1933	33,276,000
1934	35,966,000
1935	31,825,000
1931-35	34,336,000

years, brought thousands of people to the state. They came altogether too rapidly for their own best interests and for the ultimate good of the state. Our advice to the people of the state was not to hasten this immigration but the agencies working in the other direction brought rapid settlement of the dry lands.

The effect of this settlement was to break up the old type of ranch livestock industry and compel its reorganization. The first effect was to decrease the number of cattle on the range and at the same time increase the number of owners. Sheep numbers for a time were maintained and then dropped off rapidly.

With these changes in numbers there is also evolving a change in the management of the livestock industry in Montana. The trend with cattle seems to be toward a cow and calf herd

in the more favorable pasture areas with perhaps an increase in the number of animals finished for market in fed lots. In the less favored pasture areas and where farm grain or forage is not readily available, animals may be grown to a more mature age and finished for market on grass with perhaps a grain supplement. Another tendency is toward adequate sized ranches and a more complete control of the range pasture which will tend toward better management of the range and will lessen risks in the industry. Accompanying this should be an improvement in the quality of the herds and flocks through increased use of purebred sires. Numbers may not be so great but returns will be as large or probably larger from the improved quality. As insurance against the dry years there is a growing tendency to provide ample forage for the winter and a surplus to help out in recurring dry years.

The livestock industry on the range has had in the past too large a speculative and gambling element—to make a stake and quit. We believe the time is here when the speculative element must be minimized and plans worked out that will give as steady and safe an annual income as possible in a lifetime occupation.

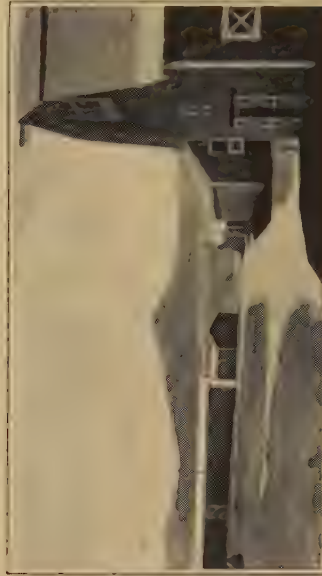
In this report the endeavor is to give information concerning the service of the Experiment Station to the livestock industry of the state and to show the facilities available for this service. In the following pages the departments tell how they help.

STUDYING LIVESTOCK PROBLEMS

AT THE HOME STATION

The Department of Animal Husbandry maintains livestock of the various classes for the purpose of securing information on feeding, breeding, and management problems that will be of benefit to the industry. Beef cattle investigational work is conducted at Bozeman, Havre and Moccasin and, in addition, studies are made in cooperation with the United States Department of Agriculture at Miles City.

The department at Bozeman is well equipped and provides a center to coordinate the studies carried on over the state. Here the work consists of feeding trials in which various rations with supplements are used in fattening cattle. Each year approximately 60 head of cattle are fattened for market. Over 80 rations



SHEEP SHEDS, DWELLING HOUSE, AND HORSE BARN AT THE FORT ELLIS FARM
THREE MILES EAST OF BOZEMAN, USED FOR SHEEP EXPERIMENTAL WORK

have been studied. In addition to the fattening steers, there are available for experimental and instructional work small herds of Hereford, Shorthorn and Angus cattle. The facilities for the feeding work at Bozeman consist of an open shed with suitable dry lots and running water in each lot. In addition, excellent irrigated pastures are available to study the gains made by steers on such pasture alone and when grain is also fed.

The sheep experimental work is centered at Bozeman where a grade Rambouillet flock of approximately 1,200 ewes is used for studying breeding and feeding problems. In addition to the ewes, from 1,000 to 1,200 lambs are available each year for feeding and fattening studies. The headquarters for the range ewes is located three miles east of Bozeman on a section of land where ample shed room and experimental equipment are provided for conducting the work. Some 5,000 acres of summer range in the Gallatin National Forest is made available to the Station and land is leased near Manhattan where work on wintering ewes on the range is being studied. Purebred flocks of Rambouillets, Hampshires and Southdowns are maintained in addition to the grade herds and are used for both instructional and experimental purposes.

One of the major problems being studied is the effect on lamb and wool production of the amount of feed given to ewes during the winter. Uniform lots of ewes are fed varying amounts and kinds of roughage and supplements during the winter period and a comparison is made of the lamb and wool production of these ewes. Studies are in progress on the value of different protein supplements fed to ewes wintered on the range, and the effect on their subsequent growth and development of the amount of winter feed fed to ewe lambs. Range utilization and lamb production are studied on the summer range.

The breeding work includes studies on the length of gestation period, influence of breed of sire on lamb production, the influence of size of ewes on their lamb and wool production, and the influence of heredity in the production of twin lambs.

In lamb fattening work comparisons are being made on the use of self feeders and feeding grain twice a day; the effect on the rate and economy of gains of various kinds of rations; and the value of different protein supplements when added to the fat-



NORTHERN MONTANA BRANCH STATION NEAR HAVRE. ABOVE, CABINS FOR HERDER ON THE SUMMER RANGE; CENTER, CORRALS AND HORSE SHED ON SUMMER RANGE; BELOW, FEEDING SHED AND YARDS AT HEADQUARTERS

tening rations. Over 45 feed combinations have been used to secure information of value to lamb feeders. A study is also being made on the influence of the weights of feeder lambs on their rate and economy of gains.

Dairy cattle and hog experimental work is conducted at Bozeman where excellent physical equipment is provided. There are available for dairy work 50 head of cows and heifers and studies are being conducted to determine the cost and production records of cows fed alfalfa hay alone as compared to alfalfa and a limited grain allowance. Rye as a feed for dairy cows has been studied as well as many other feeds. Various rations and methods of feeding heifer calves have also been studied.

There are approximately 25 registered Duroc Jersey sows and over 200 pigs available for feeding tests each years. Studies are conducted on the value of wheat, barley, and various grain combinations, with and without protein supplements, for fattening fall and spring pigs. A study has been made of different kinds of pasture and the effect of limiting the amount of grain fed on pasture in fattening spring pigs. Over 100 rations for fattening pigs have been studied. An investigation of the deficiencies of barley as a feed for hogs is now being conducted. Data on variations in rate and economy of gain of different litters of pigs are being studied as well as brood sow rations. This experimental work is planned to give the livestock industries of the state timely and authentic information.

AT THE NORTHERN MONTANA BRANCH STATION

A range herd of approximately 150 head of grade Hereford cows of breeding age is maintained at the Northern Montana Branch Station, near Havre. An open shed 288 feet long, divided into 8 pens open to the southeast with lots adjoining each, is used for feeding and fattening young cattle. On the valley of Beaver Creek, adjoining the feeding shed, are brush protected feeding yards. These are also used for winter feeding of cattle. At the Station's headquarters there are 2,000 acres of land. In addition grazing problems are being studied on some 5,000 acres of land leased from the Rocky Boy Indian Reservation.

Experiments have been conducted in fattening steers for the late fall market on northern Montana grown feeds; wintering

heifers on a high and a low plane of nutrition; and wintering beef cows on various locally grown roughages.

A very important factor in satisfactory returns from the beef herd is to keep feed costs as low as possible. This problem has



JUDITH BASIN BRANCH STATION. ABOVE, OPEN SHED FOR WINTER FEEDING; BELOW, DAIRY BARN

been studied from two angles. In growing out heifers, comparisons have been made between limited and full feeding with different kinds of roughage during the winter season. This test starts with the beef calves and is continued for three winters, or until as cows they are added to the breeding herd.

The heifer calves fed the limited ration during the winter period cost 45.2 per cent less than those full fed; the yearlings 42.3 per cent less and the 2-year olds 55.7 per cent less, but they gained much less in live weight than did those full fed during the winter. During the following pasture season, however, the heifers fed the limited ration gained much more than those well fed in the winter but they did not equal the total yearly gain of those well fed, although the cost of the gain was less. As 3-year olds the heifers well fed weighed 96 pounds more than those limited fed.

Another test at this station is in the use of a large type and a small type bull with the breeding herd. In 1935 calves sired by the large bulls weighed 10.5 pounds more at birth and were 59.8 pounds heavier at weaning time than those calves sired by the small type bull. The calves from the large type bull continued to make greater gains as yearlings and 2-year olds.

AT THE JUDITH BASIN BRANCH STATION

A herd of 30 Milking Shorthorns is maintained and used mainly to study the value of the pasture and fodder crops grown in cropping and other tests at the Judith Basin Branch Station, near Moccasin. There is a small barn for the dairy cows and an open shed for winter feeding of the other livestock.

A very important study at this station, for the livestock producers, is in contrasting the carrying capacity, length of the grazing season and the gain made on crested wheatgrass, brome grass and native pasture. The results of these tests are given under the report from the Agronomy Department, page 39.

AT THE HUNTLEY BRANCH STATION

The Experiment Station at Huntley, owned by the United States Department of Agriculture, is operated in cooperation with the Montana Experiment Station. It was established to study the cropping problems of farmers on the irrigated land along the valley of the Yellowstone River. An important crop in this valley is sugar beets. The tops and pulp are marketable only as feed for livestock. For six years studies have been carried on to determine the value of these by-products as a fattening ration for range lambs, when fed in combination with varying amounts of hay and grain. These tests show that larger gains and a better

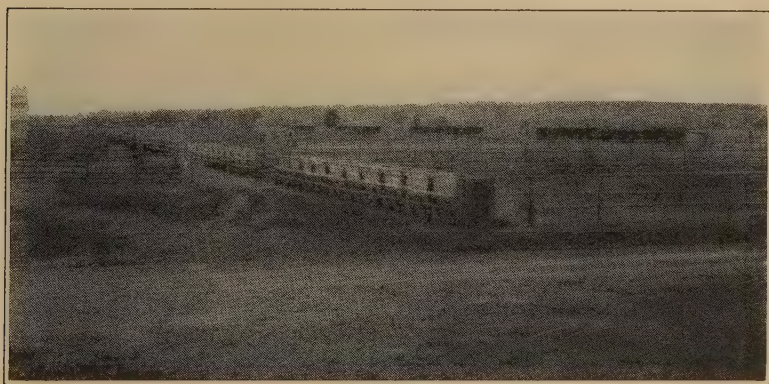


VIEW OF THE BUILDINGS AT THE HUNTLEY BRANCH STATION

finish have been obtained when sugar beet by-products are fed. Oats combined with pulp and alfalfa have given the best results, with wheat, instead of oats, a close second.

For seventeen years studies with dairy cows have been in progress at the Huntley Station. An important fact developed in the feeding work has been that high quality roughage fed alone to good dairy cows will produce milk and butterfat more economically than when grain is fed. Alfalfa hay alone or grass hay as grass silage, made from pasture grasses, when fed to cows produced consistently about 400 pounds of butterfat annually. The quality of the roughage is improved by harvesting before it is too mature.

Another important experiment at this station is the study of the effect of using high grade purebred dairy sires on the grade cows of the district. The production record of some 580 daughters of 57 sires used by the dairymen of the district was 11,203 pounds of milk, testing 3.6 per cent butterfat, with a total of 403.7 pounds of butterfat per year, as compared with 9,707.4 pounds of milk at 3.57 per cent butterfat and 346.3 pounds of butterfat per year for the dams of these daughters—a gain of 1,495.6 pounds of milk and 67.4 pounds of butterfat. The important factor in this experiment is the selection of dependable high production sires and the ultimate building of uniform herds of dependable high producing animals.



CORRALS ADJOINING CATTLE BARN AT THE UNITED STATES
RANGE LIVESTOCK EXPERIMENT STATION

AT THE UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION

The United States Range Livestock Experiment Station, near Miles City, is the largest field station of the United States Department of Agriculture devoted to the study of the livestock problems of the West. The Montana Agricultural Experiment Station is cooperating with the federal authorities in the work being



UNITED STATES RANGE EXPERIMENT STATION ABOVE, SHEEP BARN, CENTER, CATTLE FEEDING BARN; BELOW, HORSE BARN

carried on. The studies with livestock are supplemented with studies of range grasses, the carrying capacity of the range, and the effect of various intensities of summer and winter grazing with both cattle and sheep.

This station comprises some 65,000 acres of range land made up of plains, rolling hills and badlands. Water in the range country is supplied partly by wells and by reservoirs, which are being

increased in number. Some 2,000 to 3,000 acres are irrigated and used to grow winter feed, mainly alfalfa. The station headquarters has barns and sheds for cattle, horses, sheep and hogs. At present some 800 cattle, 100 horses, 300 sheep and a limited number of hogs are available for the experimental studies.

The majority of the studies at this station are with beef cattle. A careful record is kept of each animal from birth through to fattening for market or to maturity. The performance of the individual animal under a great variety of feeding and manage-



SHEEP ON RANGE AT THE UNITED STATES RANGE EXPERIMENT STATION

ment practices is fully noted. The scope of the problems under investigation has included range wintering trials with breeding cows to determine the value of a high protein supplement; feed lot trials with calves to determine the more efficient and economical winter rations; plane of nutrition studies with steers, calves, yearlings and two-year-olds to determine the optimum amount of feed required to produce the most economical gains; grazing studies with breeding cows to determine the proper rate of stocking native short grass ranges under summer and winter conditions; fattening trials with local feeds and record of performance studies to determine a satisfactory basis for the evaluation of excellence in range cattle.



WATERING HOLE AND RANGE AT THE UNITED STATES RANGE
EXPERIMENT STATION

OVERCOMING ANIMAL DISEASES

Veterinary service is recognized as essential to the success of the livestock industry. Three types of veterinary services are available to Montana stockmen. The first of these is that of the private practitioners. The second is the work of the Livestock Sanitary Board in the control and eradication of communicable diseases of livestock and the protection of Montana stockmen against the introduction of communicable diseases from outside the state. The third agency, giving service to the stockmen, is the Veterinary Research Laboratory at Bozeman. This laboratory is administered under a cooperative arrangement between the Montana Agricultural Experiment Station, the Montana Livestock Sanitary Board, and an advisory committee whose membership includes representatives of the Montana Stockgrowers Association and the Montana Woolgrowers Association. The laboratory is operated in close contact with the office of the Livestock Sanitary Board, and thus keeps in touch with the animal disease conditions throughout the state.

The laboratory has a staff of four members with a helper to care for the livestock and a varying number of extra laboratory help during portions of the year.

Without a large investment in buildings, the laboratory is fairly well equipped to carry on investigations on many diseases affecting livestock. The laboratory and office building have the necessary facilities for doing general bacteriological, pathological, and parasitological work. The hospital building contains an operating room and space for housing sick animals and animals being used in experiments. There are two other buildings used principally for sheep experiments. The veterinary area includes about five acres of land on which are the buildings and a system of corrals and small pastures.

While experimental work is done on the diseases of the three principal classes of domestic livestock in Montana—cattle, sheep, and horses—somewhat more emphasis has been laid on the study of sheep diseases than on the diseases of other livestock. This was the result of special demands for studies on sheep problems, and the fact that no other experiment station was giving particular attention to diseases of range sheep. To have a supply of sheep of known history for experimental work, the laboratory owns a flock of from 100 to 150 ewes, keeping the number up by retaining ewe lambs from the flock. Complete individual his-



VETERINARY RESEARCH BUILDING

tories are kept on these sheep from birth to death. In many cases one sheep has served as experimental material in several projects.

Studies have been selected on the basis of their importance to Montana stockmen and no attempt has been made to work on subjects being investigated by other laboratories. The cattle projects have been selected in an attempt to solve phases of certain problems more or less peculiar to Montana conditions. For instance, Bang's disease, or infectious abortion, has been studied extensively all over the world. However, practically none of



ONE OF THE LABORATORIES IN THE VETERINARY RESEARCH
BUILDING

this outside work has covered some of the special conditions of the range country of the West. This laboratory, therefore, has investigated certain phases of the control of Bang's disease solely from the standpoint of the application of these control measures to range cattle.

Studies on several research projects of the laboratory have given results of real value to the stockmen of the state. Other problems, though studied for years, are yet unsolved, but additional facts are continually being brought to light.

CONTROLLING INSECT DAMAGE

Many important insect problems are intimately associated with livestock production in Montana. The annual tax levied by insects on our livestock industry is enormous even for ordinary years. During seasons like 1934 and 1935, when grasshoppers, crickets, and ticks are unusually abundant, very conservative estimates of these losses reach such size that they become unbelievable. In average years the loss would exceed 10 per cent of the value of all livestock, hides, forage crops, and range grass. In some recent years a fair estimate would reach 20 per cent. We readily appreciate acute cases of animal injury or range destruction caused by insects but ordinarily we fail to attach much importance to the constant impairment of animal strength and forage resources caused by these organisms.

In general the insect and allied enemies of livestock fall into two classes as follows:

1. Parasites, both internal and external. Some of these cause only severe irritation or annoyance; others are responsible for a general and often acute debilitation of the animals; a few species transmit important diseases. Grouped together the main ones are lice, sheep ticks, warbles, bots, black flies, horse flies, mosquitoes, and ticks.

2. Insects which destroy range and forage crops such as cutworms, webworms, grasshoppers, crickets, and a host of rather minute plant feeders which usually escape our attention.

At least thirty distinct species are concerned in the first group. It is the function and duty of the Department of Entomology to study the insect side of this problem and to cooperate with the veterinarians in the application of new data on insect parasites to the general solution of many vexing questions involved in the problem as a whole. At present there is no lack of information on some of the insects listed above; there is, however, a great lack of practical methods and equipment for applying that information. The simplification of the dipping process, the use of sprays in treating cattle down with tick paralysis, and the determination of the value of new insecticide materials for external parasites are subjects which need investigation. With such insects as black flies, mosquitoes, bots, and warbles, control

is made very difficult by the fact that community and district cooperation are absolutely essential. In the case of horse flies there is not yet available sufficient information on which to base even an attempt at control other than the use of repellant sprays.

In the second group of insects are no less than fifty important species. Topping the list of course are the grasshoppers and crickets. The problem of control in the case of these pests comes down to a question of the possibility of reducing the cost of poisoned baits to an extent where they can be used economically on range areas. When the value of forage is high, baiting at about fifteen cents per acre is very practical and effective. But when the cost of baiting equals the leasing cost of the range itself, then the value of using poison against the insects becomes somewhat questionable. In Montana in 1935 some four million acres of range was severely damaged by grasshoppers and crickets. In many cases stock had to be moved from their common summer range to distant areas at very heavy cost to the owners. Improved methods of combatting these pests, perhaps going to the airplane as a means of spreading bait at low cost over wide areas, are being investigated and should yield some results extremely valuable to the Montana stockgrower.

A PROBLEM IN NATURAL REGRASSING

An important factor in relation to the livestock industry of Montana is the regrassing of the abandoned land in the state. To secure definite information on this important question the Botany Department began in 1929 a study on the "Succession of plants on abandoned land." During the six years following 1929 some important observations have been made and valuable results obtained.

Most of the land in the eastern two-thirds of Montana is in a semiarid region and the formation of sod on such land was a very slow process. When this sod is impaired or destroyed natural restoration is very difficult and requires many years. Most of this region consists of the short-grass association, the large volume of the vegetation being grama grass, needle grass, wheat grass, etc.

For this experimental study four plots were selected and the actual date of the last crop year was secured, as follows:

Plot A. Native sod.

Plot B. Plowed in 1910, cultivated for a short period, abandoned. Plowed and cropped 1920-21, then abandoned.

Plot C. Plowed in 1910-12. Cultivated eight years. Uncultivated since 1920.

Plot D. Plowed in 1910-12. Cultivated up to 1928, uncultivated since.

Plots A and B have been grazed rather heavily by sheep during the years of the experiment. Plots C and D have been grazed rather lightly for the same period. In general, plot A has reached its short-grass climax and the volume of feed depends primarily upon the rainfall. In plot B the ground was poorly broken and the sod was not entirely killed, so revegetation almost to the state of plot A took place very rapidly. However the sod on Plot B is not quite as dense; there is less area actually covered by sod; and the annual and perennial plants, other than grass, are slightly more numerous.

Plot C is past the annual weed stage. The more common plants are silvery sage, annual grasses, a few patches of perennial grasses, and some other annual and perennial flowering plants.

Plot D is practically covered with annual weeds, mostly some form of mustard with only a few other plants present.

To summarize these facts, the revegetation of land where the sod has been entirely killed occurs in four stages which require various periods of time, during which rainfall is largely the limiting factor in the rate of regrassing.

First, there is the annual weed stage, in which the mustards are prevalent for probably four to six years. Second is the transition stage between annuals and perennials when the annual weeds gradually decline and silvery sage, broom weed, and other flowering plants appear, together with a few of the grasses. Third, the grasses such as June grass, needle grass, etc., become dominant and the sod forming perennial grasses gain a foothold. In the fourth or final state, the dominant grasses are perennial wheat grasses, grama grass, etc., with only a few other species.

The period required for the complete restoration of the grass will vary greatly but a very conservative estimate is twenty-five years, and in some known instances natural revegetation equal to the native sod has not taken place over a period of fifty years.

There was perhaps some excuse in the early settlement of the state for plowing the native sod in areas where the kind of soil and the cover showed vigorous vegetation in the past. However with the experience and studies of the past twenty-five years, a repetition of this practice should be confined to those areas where it has been demonstrated that long-time successful cropping is possible and fairly profitable.

THE DEVELOPMENT OF WATER RESERVOIRS ON THE RANGE

The severe and prolonged drought which Montana, along with other western and midwestern states, has experienced has halted the advance of the dry farmer onto the diminishing domain of the stockman—the open range—and in some parts of the state deserted homesteads stand as mute evidence of the retreat of the farmer and the return of land to the grazing of livestock.

But the relinquishment of land by the homesteader has not restored the “good old days” of the free and open range. The unlimited range and the three and four year old steers, with endurance to survive extremes of weather, scarcity of feed, and scarcity of water, will never return. The steer has been replaced by the cow and calf.



A STOCK WATER RESERVOIR

This means that the stockman may now profitably improve the permanent range by reseeding, developing water holes advantageously located, and by providing a feed reserve to carry the livestock through hard winters and dry seasons. Reseeding of the land which has proved unsuited to cultivation will take place slowly, but may be accelerated by practices of flood irrigation, and by conserving the runoff from rough unproductive land by directing it onto adjacent creek bottoms and other land suitable for pasture and for raising hay, grain or other feed crops.

Small reservoirs may be built in coulees and in intermittently flowing stream channels to store drinking water for cattle. These reservoirs must be located at intervals of two and a half to three miles apart to avoid overgrazing around water holes and to utilize fully the grass over the entire range. Many times during the past years of feed shortage, good grass existed several miles away but could not be used because of lack of water.

The Irrigation Department of the Station has been actively engaged in solving problems of water conservation and use in sections of the state which have suffered from drought. Successful flood irrigation methods have been developed, based on the actual experience of many farmers and stockmen. The runoff from melting snow in the spring and from heavy rains in the summer may be stored in the soil to produce good crops of hay and feed for winter feeding or reserves for hard winters and dry years; or it may be stored in small reservoirs to provide stock water and thus enable the stock to make better use of the feed on the range.

"Conservation of Water by Means of Storage Reservoirs, Diversion Dams, Contour Dikes and Ditches" (Bulletin 301) describes methods of flood irrigation; the selection of reservoir and dam sites; the construction of dams, dikes, and ditches; and gives certain basic information pertaining to rainfall and runoff which is necessary in designing and building a flood water system or a stock water reservoir.

ECONOMIC ASPECTS OF LIVESTOCK PROBLEMS

LIVESTOCK MARKETS

Montana ranks eighteenth in the number of cattle and calves on farms and second in sheep and lamb production—exceeded only by Texas—and is thirty-first in hog production. The cattle population is scattered over the entire state; the five leading counties in number of cattle are Beaverhead, Fergus, Powder River, Chouteau, and Custer. The five leading counties in sheep production are Madison, Beaverhead, Blaine, Cascade, and Powell, and those leading in hog numbers are Gallatin, Fergus, Lake, Ravalli, and Richland.

The average disposition of the livestock from 1926 to 1931, inclusive, is shown in table 4. The central markets are of primary importance, although livestock shipped out of the state can go to any one of a number of markets.

TABLE 4.—DISPOSITION OF MONTANA LIVESTOCK, 1926-1931

Disposition	Cattle and calves	Sheep and lambs	Hogs
	Per cent	Per cent	Per cent
Farm slaughter	6.7	1.8	31.0
Local slaughter	14.3	3.8	26.0
Shipped to central markets.....	79.0	94.4	43.0
Total	100.0	100.0	100.0

About 40 per cent of the cattle shipped goes to the Chicago market and 22 per cent to South St. Paul. Next in favor are the Omaha, Sioux City, Spokane, Salt Lake City, Ogden, Tacoma, and Portland markets, in the order named. Eleven and one-half per cent of all Montana cattle are shipped to western markets. About 40 per cent of Spokane's cattle receipts come from Montana. Most areas in Montana can ship to eastern and western markets with direct transportation facilities. A few counties in south-central Montana have direct connections with Omaha, Sioux City, Ogden, and Salt Lake City markets. In general, all markets are important, but of varying degree to different counties.

During the period studied, 82.5 per cent of Montana's sheep and lambs were shipped to Chicago and South St. Paul. Of the balance, the majority went to Denver and Ogden markets. Thir-

ty per cent of South St. Paul's receipts of sheep and lambs come from Montana.

Most of the Montana hogs are shipped to western markets. In general, the light hogs are sent west and the heavy hogs shipped east. During the years 1928 to 1931, 83.5 per cent of the hogs were shipped to western markets.

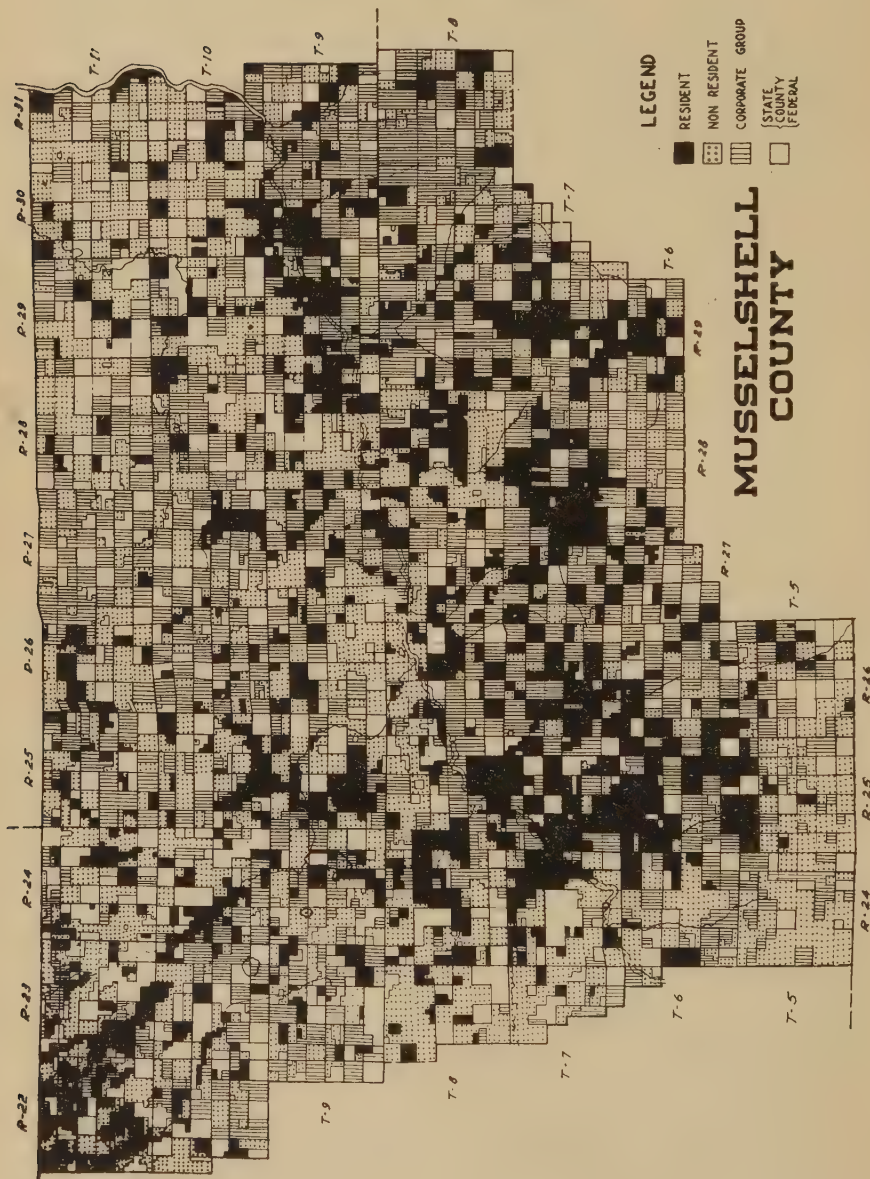
While transportation facilities largely dominate the Montana livestock marketing pattern, other factors assist in determining the destination of shipments. Friendly commission merchants, good advertising, prejudice, market demand for various classes and grades of stock, all have a bearing on the problem. Such items as shrinkage, yardage, and insurance are also influential.

PRODUCTION PROBLEMS

Age of Marketed Cattle.—A trend is indicated toward the production and sale of younger animals in the state. A significant change occurred between 1930 and 1935 in the relation of cows and heifers two years old and older, to the total cattle population of the state; the former increased 41.8 per cent while the latter increased only 33.5 per cent.

This trend occurred in nearly every county of the state. The counties of Dawson, Prairie, Custer, Powder River, Fallon, and Carter, which had a decrease in total cattle numbers between 1930 and 1935, because of heavy drought sales in 1934, show a much lower percentage decrease in cows and heifers than in the total number of cattle.

Range Carrying Capacity.—A major problem concerns the relationship between available range, carrying capacity, grass depletion and the number of livestock. There is widespread indication that much of our range land, both privately and publicly owned, is overgrazed. This problem is partly the result of promiscuous homesteading and the attempt to crop land actually too poor to farm. Other factors in the problem are the number of relatively dry years, beginning in 1930 and extending almost uninterruptedly to 1935, and the low prices for livestock accompanying the general business depression beginning about the same time. The one checked grass growth, the other encouraged withholding stock from market and built up livestock numbers out of proportion to range carrying capacity.



OWNERSHIP PATTERN OF MUSSELHELL COUNTY

RELATIONSHIP OF LAND CONTROL TO LIVESTOCK

Land Ownership and Tenure.—In the settlement of the dry land of the state, the range areas were divided into thousands of small tracts through settlers taking up 80, 160, 320, or 460-acre tracts under the homestead acts. The land was cut up still more by thousands of eastern speculators who bought land in 40-acre, quarter or half-section units in the belief that land values would rise through rapid settlement and development, or through the discovery of oil and valuable minerals. These and many other factors have influenced the settlement and use of Montana land until today the ownership pattern, particularly in the eastern two-thirds of the state, is very broken, as illustrated by the map of Musselshell County.

With such an ownership pattern, economic instability, overgrazing, and general misuse of land occurs. Holdings are far too small for economical range units. Studies by this Station show that with the soil characteristics and carrying capacity typical of much of Montana's range an operator with a unit of 100 head of cattle—which is a small range unit for any family entirely dependent on this enterprise—would require about 4,000 acres, unless good supplementary feed is available. This is based on an analysis of 12 representative counties of the state where approximately half of the grazing land was of a grade which would require a minimum of 40 acres per head of cattle.

The splitting up of the land into these small uneconomical units makes it necessary for most operators, in order to approach an economic unit, to lease from numerous, usually unknown, landholders who may be scattered over a wide area. The operators have no assurance from year to year that they can maintain their entire operating units intact. In addition, their lease rates may be raised by the competition of neighboring livestock owners. Thus uncertainty in range control encourages severe overgrazing and misuse of the land resources. If these small parcels could be grouped or blocked out into units of proper size they could be more adequately controlled and their carrying capacity improved and maintained.

Considerable progress has been made in the past two years by the voluntary grouping together of ranchers in cooperative grazing districts and the acquisition and effective control of given

areas. The federal government is assisting in this endeavor through the Taylor Grazing Act and the Land Utilization Division of the Resettlement Administration. These agencies, through outright purchase of numerous small privately owned tracts, are trying to improve the land ownership pattern for the benefit of the ranchmen. Much research is still needed in connection with these programs to determine their effect on local government and taxes, on total agricultural production and prices, and on land resources. The Experiment Station now has several research projects in progress in an attempt to determine some of these facts and make them available to Montana stockmen.

The Problem of Tax Delinquency.—The failure to adjust our agricultural practices to the natural factors which control the productivity of land, and the failure of local governments to adjust taxes to ability to pay are fundamental causes of the large farm tax delinquency in Montana. Drought and low prices during the depression have aggravated the situation and emphasized the more important effects of these maladjustments in land use.

Studies in tax delinquency show that a larger proportion of the smaller than of the larger farm properties is delinquent. They also show that taxes are paid more promptly by resident than by nonresident individuals. The high percentage of nonresident ownership in many sections of Montana, combined with the large number of small tracts into which the land has been divided, creates inefficient farm units and uncertainty in range control. The resulting severe overgrazing and misuse of the land leads to increased tax delinquency.

The changes which are and will be made in the land use pattern of the state, either by planned group action or by the crude law of the survival of the fittest, will make possible many important adjustments in local government. These changes should result in reducing tax burdens for the support of schools, roads, and other local governmental services, and thus help to reduce farm tax delinquency.

The actual tax paying ability of the various grades of range land are being studied by the Montana Station. Preliminary findings show that with the exception of first grade land all other grades carry a tax burden far out of proportion to their ability to pay. These studies show that the average grazing land is taxed

heavier in proportion to ability to pay than similar grades of farming land. In this connection the Experiment Station is studying adjustments which might be made in the tax system and the savings that might be made by more centralized direction of county and school district governments. These studies include changing the tax system by broadening the tax base and supporting certain socially necessary function, such as roads and schools, by a combination of local, state and federal taxes rather than by local assessments alone. These studies should point the way to harmonizing taxes with the benefits received, and the ability to pay, and should do much to reduce tax delinquency in the rural areas.

Mortgage Foreclosures and Farm Credit.—The trend of farm mortgage foreclosures in Montana has been downward since 1926 although there was a tendency for foreclosures to increase during the early depression years, 1930 to 1933. The total farm mortgage debt in Montana decreased about one-third during the decade 1920 to 1930, not so much because of repayment of mortgages as because of bankruptcies and foreclosures.

The decrease in farm mortgage foreclosures since 1933 is due in part to the following: (1) better prices of agricultural products, (2) the ready cash made available through certain federal programs, and (3) increased lending by quasi-governmental agencies such as the Federal Land Bank, the Regional Agricultural Credit Corporation, the Production Credit Association, and others.

The fundamental causes of farm mortgage foreclosures are very similar to those of tax delinquency; namely, improper use of the land, the drought, and the depression. Improvement of general business and price conditions, reduction of damage from drought and insect pests, and adjustment of agricultural practices would reduce mortgage foreclosures appreciably.

The Experiment Station, through its studies, is attempting to make available to Montana ranchmen information which will assist them in adjusting land utilization practices to the natural requirements of the land. If loans are made on the basis of soil productivity and payments adjusted to ability to pay, depending upon fluctuation in the general price level and yields, mortgage foreclosures as well as tax delinquency will be reduced to a minimum. Considerable research must still be done in analyzing soil productivity and the ability of ranchmen to liquidate loans and meet other costs.

RELATION OF SOIL AND CROP STUDIES TO THE LIVESTOCK INDUSTRY IN MONTANA

The program of agronomic research, as it applies most directly to the livestock producers of this state, concentrates on problems of crop and soil management which will eventually lead to larger and more dependable supplies of feed, both grain and forage, to the end that the livestock industry may be placed upon a more permanent and profitable basis.

CLASSIFYING LAND FOR PROPER USE

It was a wise old Indian, who, pointing to the early settlers newly turned sod, remarked, "Wrong side up." Experience has proved conclusively the truth of the oft repeated statement that "millions of acres of land have been plowed and prepared for crops which should have been retained for the grazing of livestock."

Since July 1, 1921, the Agronomy Department has been making a systematic inventory of the soil resources of Montana in an effort to assist in adjusting some of the land problems of the stockmen. The more important soil types of the state are being mapped and essential data are being gathered as a basis for classifying land for proper use. Up to date, the soils in twenty-three counties, comprising almost one-half of the area of the state, have been surveyed and mapped and the land has been classified according to the use to which it is best suited. The land classification maps separate the grazing land from the farm land and designate the various grades of each as follows:

Grazing Land.—Nonirrigated land adapted to grazing, and which should be used only for grazing. The grades below are based on carrying capacity or the acres per cow unit for ten months.

First grade, 17 acres (black or very dark brown soils)

Second grade, 18 to 26 acres (dark brown soils)

Third grade, 27 to 38 acres (brown soils)

Fourth grade, 39 to 57 acres (light brown soils)

Fifth grade, 58 acres and over (badlands, etc.)

Farm Land.—Nonirrigated land which has been graded on its ability to produce spring wheat on summer fallow over a long term of years:

First grade, 22 bushels or more per acre.

Second grade, 16 to 21 bushels per acre.

Third grade, 11 to 16 bushels per acre.

Fourth grade, 8 to 11 bushels per acre.

With grazing land definitely located and graded on the basis of the carrying capacity indicated, it is possible to give proper consideration to the interests of the livestock operators of the state. In the future, proposals to use grazing land for cropping should receive very little consideration. Furthermore, information is available which will be helpful in adjusting the number of livestock to the carrying capacity of the land to be grazed.

When all of the land of the state has been classified so that grazing land is definitely defined and located, with information available as to carrying capacity, a very important step will have been taken toward placing the livestock industry on a more permanent and profitable basis.

BUILDING UP FEED RESERVES

The success of any livestock enterprise is dependent upon ample supplies of feed. Not only is it essential to have pastures and ranges which will furnish sufficient forage during the grazing season to keep the stock in a thrifty condition, but reserves of hay and grain are essential at any time, especially during emergencies. The disasters due to recurring drought and extremely severe winters may be largely avoided if adequate supplies of feed grains and hay are available.

Best Varieties of Feed Grains Determined.—Whether the stockmen are operating in the irrigated valleys or on the non-irrigated bench and grazing land of the state, the Agronomy Department is prepared to furnish information as to the best varieties of feed grain.

For the Irrigated Ranch.—Years of careful testing have demonstrated the superiority of Trebi barley, Victory and Markton oats, and Federation spring wheat as varieties of feed grain for irrigated ranches.

Thoroughly adapted to the soil and climatic conditions of the irrigated lands, Trebi barley has outyielded the varieties which it replaced by as much as 20 to 30 per cent; Victory and Markton oats hold a similar advantage over former competitors; and Federation spring wheat, a white kernalled variety well adapted for

feeding, has rather consistently produced 20 per cent more grain per acre than other of our common wheats.

For Nonirrigated Land.—Horn barley, Markton and Idamine oats, and Prolific spring rye are among the best varieties of feed grains. Their advantage in yielding capacity over competing varieties make their use decidedly worthwhile. By replacing varieties of questionable adaptability with pure seed of varieties recommended by the Experiment Station, stockmen may harvest from 10 to 15 per cent more feed grain per acre with but little additional cost.

Excellent Hay from Small Grains.—For many years experiments with annual hay crops have been conducted by the Agronomy Department in an effort to emphasize practical methods of building up more adequate reserves of hay, especially in non-irrigated areas.

On irrigated land leafy varieties of small grains, such as Victory oats, and Federation and Marquis wheat, produce exceptional yields of hay. During 1934 and 1935, these three crops at Bozeman averaged respectively 6.8, 6.2, and 6 tons per acre of excellent quality hay.

On nonirrigated land, small grains seldom fail to produce at least one ton of hay per acre and often more, when planted on land which has been summer fallowed according to approved practices. On dry land it is advisable to summer fallow every second year to insure a satisfactory crop of grain or of grain hay.

Ladak Alfalfa, a New Variety.—The outstanding superiority of Ladak alfalfa for Montana stockmen has been conclusively demonstrated by experiments conducted cooperatively by the Station and the Division of Forage Crops and Diseases of the United States Department of Agriculture.

A native of India, this variety of alfalfa when grown in Montana was found to be drought resistant to a high degree and it has shown considerably more winter hardiness than any other variety commercially important in this state. In addition Ladak consistently yields more hay per acre and is leafy with medium fine stems. Stockmen, who use alfalfa, will fully appreciate the value of a variety which will withstand drought and rigorous Montana winters. Ladak is a dependable crop and will insure a dependable supply of hay.

IRRIGATED PASTURE

Many Montana stockmen are making rather general use of the results of the irrigated pasture experiments conducted at the Branch Station near Huntley in Yellowstone County. The striking results of these experiments which are of greatest interest to stockmen may be summarized as follows:

A Good Grass Mixture.—The grass mixture that has given such excellent results on this irrigated pasture is made up of smooth brome grass, 3 to 4 pounds; Kentucky bluegrass, 4 to 6 pounds; orchard grass, 4 to 6 pounds; meadow fescue, 3 to 4 pounds; white clover, 1 to 2 pounds; and alsike clover, 1 to 2 pounds; making a total of 16 to 24 pounds per acre. This mixture, commonly referred to as the "Huntley Mixture," or some modification of this formula, has been used rather extensively in this and adjoining states.

Rotation of Grazing and Irrigation.—Proper rotation in grazing and irrigation is necessary if maximum returns are to be obtained from this pasture. This requires that the pasture be divided so as to permit alternate grazing and irrigation. Irrigation water should be applied frequently and immediately after the stock are shifted to another part of the pasture. The grasses thus receive the full benefit of the water applied as the water soaks in and the sod again becomes firm before the stock are returned.

Use of Manure.—Farm manure has been very helpful to this pasture. The practice of applying a generous top-dressing of well rotted manure at the close of the grazing season and a thorough harrowing the following spring before grazing starts has proven very beneficial in stimulating and maintaining the production of the Huntley pasture.

Overgrazing and Premature Grazing.—Too close grazing by an excessive number of livestock should be avoided as well as too early grazing before the grass gets a vigorous start in the spring which will reduce the seasonal yield of the pasture. The grass should attain a growth of several inches and have a vigorous growth of leaves before grazing starts in the spring and a good stand of grass should be maintained throughout the season.

CRESTED WHEATGRASS FOR PASTURE

At the Judith Basin Branch Station, near Moccasin, a most important phase of the experimental work is the investigations

with forage crops for the feeding of livestock. About 300 acres of the station land are used for these studies and 75 acres of this are seeded to perennial grasses. All of the field crops and the pasture at this station are grown on nonirrigated land.

The outstanding results with forage grasses at the station have been with crested wheatgrass, first planted here in 1915. This seed was obtained from the United States Department of Agriculture which had imported it from India. Through the



CRESTED WHEATGRASS PASTURE AT THE JUDITH BASIN BRANCH
STATION

years this grass and its varieties have been studied both as a hay and as a pasture crop.

The first pasture experiment with crested wheatgrass was started in 1927 with three acres of pasture grazed by Milking Shorthorn cows. Good results were obtained from this pasture and the stand is still excellent after nine years of use. In 1932 crested wheatgrass and brome grass were each seeded on 23.6 acres of land for pasture tests and the same area of native sod, adjoining the seeded pastures, was set aside and each area fenced. The land seeded to the grasses had been cropped for several years to grain. In 1933 the area was only lightly pastured but in 1934

and 1935 four head of steers were turned onto each of these pastures. Condensed, the average results for the two years were as follows:

	Crested wheatgrass April 23-Sept. 13	Brome grass April 23-Aug. 26	Native grass June 7-Aug. 1
Length of grazing season.....	142.5 days	125.5 days	56 days
Average gain per head for 4 steers	291.6 lbs.	249.2 lbs.	114.6 lbs.
Total gain per pasture of 23.6 acres	1280.0 lbs.	1005.0 lbs.	458.0 lbs.

The spring of 1932 was more favorable for seeding than any year since, and an excellent stand was obtained; 1934 and 1935 were very dry seasons, the dryest in the record of the station which started in 1908. A few facts seem established: (1) A good stand can be obtained in one year on cropped dry land, (2) the grass is resistant to drought, and (3) it grows early in the spring and provides good pasture even in dry years. The observations will be continued.

At the Northern Montana Branch Station, near Havre, studies carried on for several years fully substantiate the value of crested wheatgrass as suitable for the regrassing of plowed nonirrigated land that has been cropped for several years. Tests have shown that under average rainfall conditions no special soil preparation is necessary to get a stand, provided the seed is sown late in the fall.

CRESTED WHEATGRASS SEED PRODUCED UNDER IRRIGATION

In an effort to speed up the production of seed of crested wheatgrass, the Station Agronomy Department started an experiment in 1933 to determine the advisability of producing seed of this grass under irrigation. The results obtained during 1934 and 1935 permit a report of progress. In 1934, the highest yield of cleaned seed per acre, 1,000 pounds, was obtained from a close-drilled plot planted at the rate of 4 pounds per acre. In 1925, a plot seeded in double rows spaced 24 inches apart, using 5.6 pounds of seed per acre, returned the largest yield—1,251 pounds of cleaned seed. In 1934 five methods of seeding returned an average yield of 954 pounds of cleaned seed per acre, while in 1935 the same methods averaged 1,146 pounds. This indicates that a few acres of irrigated land would soon provide all the seed needed on any farm.

THE CHEMIST STUDIES SOIL TROUBLES AND MEASURES VALUES IN FEEDING STUFFS

Several years ago this department showed by chemical analyses that forage crops grown in certain sections of Montana often did not contain enough phosphorus to meet the body requirements of the livestock in these areas. These findings suggested the possibility of low availability of phosphorus in the soil. To check this point and determine what influence a phosphate fertilizer would have on the phosphorus content of plants, a study was started in 1928. The study showed that the yield of forage crops such as alfalfa, clover, timothy, and native grasses was increased and in most cases sufficient phosphorus added to the crop to meet the body requirement of animals.

This project has been continued in order to determine the influence phosphate fertilizer has on the phosphorus content of the grain and straw from oats, wheat and barley. These crops were grown with and without phosphate fertilizer and the results showed a considerable increase in the phosphate content of both the grain and the straw when fertilizer was used, but there is a question as to whether the phosphate in the straw is yet sufficient to meet the requirements of growing animals. Animals will thrive better if a limited amount of some supplemental food, such as cottonseed meal, is supplied them.

The department is conducting studies in cooperation with the soil survey in an endeavor to map the areas of the state where soil deficiencies occur. In addition, these studies will indicate where probable mineral deficiencies in forage crops are to be found. Studies are also in progress on methods of correcting the deficiencies.

Where soil and forage deficiencies are marked, cattle sometimes develop abnormal appetites, as evidenced by their chewing bones and eating soil—traits which appear to become habits. Under these conditions the animals do not thrive and may even die from a weakened condition. The feeding of bone meal, or a phosphate salt, or even some supplemental food rich in phosphate, will overcome this condition. However this special feeding must be continued if the animals are kept on soil deficient areas, or the quality of the forage must be improved by liberal applications of phosphate fertilizer to the soil on which the forage is grown.

DRY-LAND PASTURES FOR HOGS

Experiments have been in progress at the Huntley Branch Station* since 1915, to study the value of annual and perennial crops as pasture for hogs. Information on the following points was desired:

1. The adaptability of certain crops for pasture, the dates when they become available for grazing, and the length of their grazing period;

2. The possibility of arranging a number of crops in a rotation or otherwise, so that their combined pasture periods, when properly fitted together, would provide continuous grazing over a considerable length of time;

3. The carrying capacity of the crops used.

The crops used in these experiments have included winter rye, field peas, barley, corn, Sudan grass, soybeans, sorgo, alfalfa, and brome grass. Spring pigs have been used to graze the seven annual crops, and fall pigs have pastured the alfalfa and brome grass. In addition to the forage the spring pigs have received a daily supplementary ration of skim milk and shelled corn, whereas the fall pigs have been fed a supplement of shelled corn at the rate of 3 pounds of corn for 100 pounds of hogs.

Pasturing Annual Crops.—Usually 2 sows and their litters of about 15 pigs have been placed on an acre of winter rye about May 19, which supplied grazing for an average period of 42 days. The pigs averaged a gain of 0.79 pound each day. Supplementary feed consumed has been at the rate of 3.99 pounds of grain for each pound of gain.

Following the rye pasture, the 15 pigs without the sows were placed on an acre of field peas which carried them for an average period of 25 days with an average daily gain of 1.04 pounds. For each pound of gain supplementary grain consumed amounted to 3.04 pounds.

The pigs were then placed on a pasture of one-fourth acre of Sudan grass and one-fourth acre of soybeans for 27 days. They made a daily gain of 1.18 pounds each. In addition to the pasture 3.77 pounds of grain for each pound of gain was fed.

The next pasture, consisting of sorgo and soybeans, one-fourth acre of each, provided grazing for the 15 pigs for an aver-

*In cooperation with the Bureau of Plant Industry, U. S. Dept. of Agr.

age length of 21 days. The average daily gain was 1.34 pounds to the pig and the supplementary feed consumed was 4.1 pounds of grain for each pound of gain.

The pigs were next placed on a one acre plot of mature corn and had access to alfalfa hay as a supplemental feed. An acre of corn supported an average of 10 pigs for a period of 19 days and produced an average daily gain of 0.83 pounds. The average yield of corn from the check plot has been 15.6 bushels to the acre.

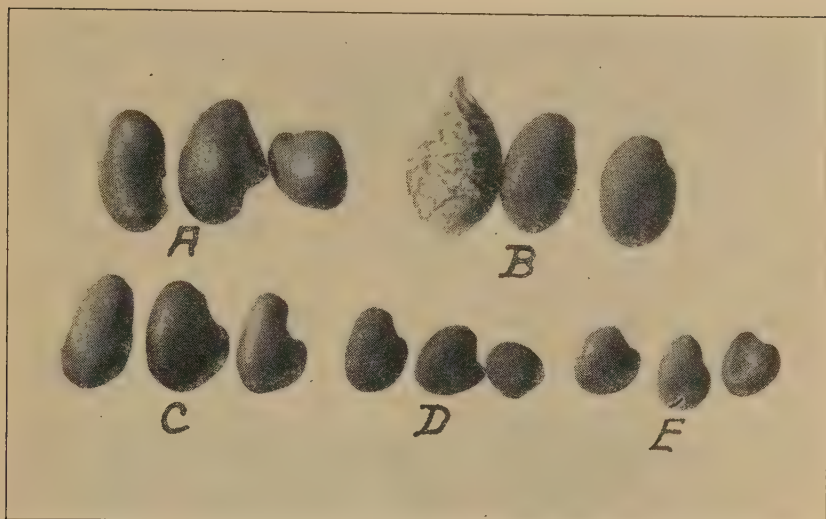
Thus, in a normal season the combination of dry-land annual crops has furnished continuous grazing for spring pigs from May 19 to October 1, a period of 135 days.

Pasturing Perennial Crops.—The experiments in pasturing perennial crops have indicated that alfalfa when used for grazing hogs is superior to brome grass in palatability, carrying capacity, and ability to maintain a stand. Both crops have been ready for grazing at an average date of May 16, and have been stocked at the rate of 6 fall pigs to an acre. The average grazing period for both crops has been 50 days, but in nearly every year the amount of palatable forage was less on the plots of brome grass than on the alfalfa pastures. The average daily gain on alfalfa was 1.29 pounds to the animal, whereas the hogs on brome grass returned an average daily gain of 1.05 pounds, with a correspondingly higher consumption of supplementary feed for each pound of gain. Hogs pastured on alfalfa and brome grass grown in rows have generally made greater and more economical gains than those pastured on close-drilled plots of the same crops. The gains of hogs on perennial pastures have generally been more economical in the amount of supplementary feed consumed than hogs in a dry pen without pasture.

THE RETURNS FROM GOOD CROP SEEDS

Good seed for meadows and pastures is of vital importance to the stockmen of Montana. Well-adapted seed, which will grow well and is free from injurious weed seeds, is in demand. The Grain and Seed Testing Laboratory, established in 1913, has done much in the past to make such seed available and is equipped to render service in the future.

An important part of the work of the laboratory is the identification of forage crop seeds, examination for the presence of



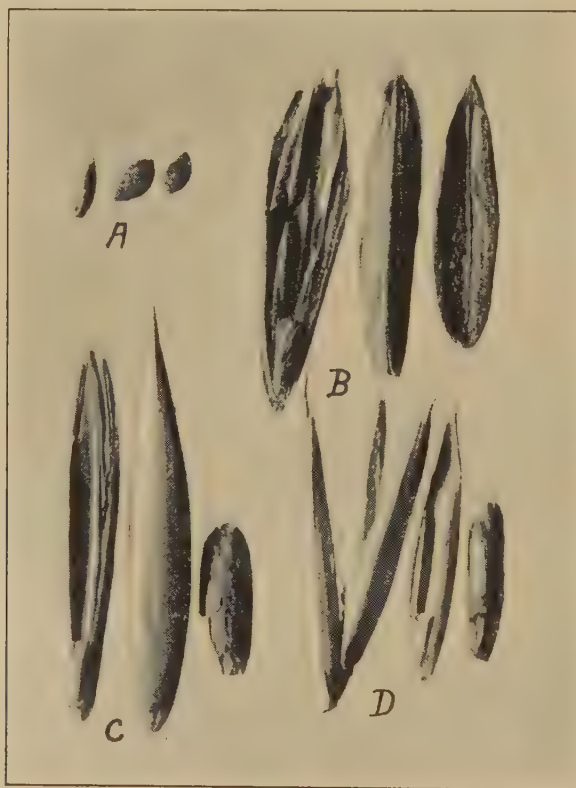
SEEDS OF LEGUME FORAGE CROPS (MAGNIFIED 6 DIAMETERS).
A. ALFALFA; B. SWEET CLOVER (ONE SWEET CLOVER SEED IS
SHOWN IN THE HULL); C. RED CLOVER; D. ALSIKE CLOVER;
E. WHITE CLOVER

weed seeds, and determination of the percentage of live seeds. The appearance of the seeds of some of the more important grasses and legumes is shown on pages 45 and 46.

All agricultural seed offered for sale in the state must be labelled to show the kind of seed and weed seeds present, and the germination of such seed. Each spring, the laboratory sends out an inspector who examines the seed stocks on sale to determine how the seed is labelled and tests are made to determine the accuracy of the labels. This work is done to protect the buying public and to maintain the standard of seed offered for sale. This guards against the selling of freak seeds at a fancy price and the dumping of inferior seeds into Montana. Emphasis is placed on the fact that only seeds adapted to Montana conditions should be offered for sale.

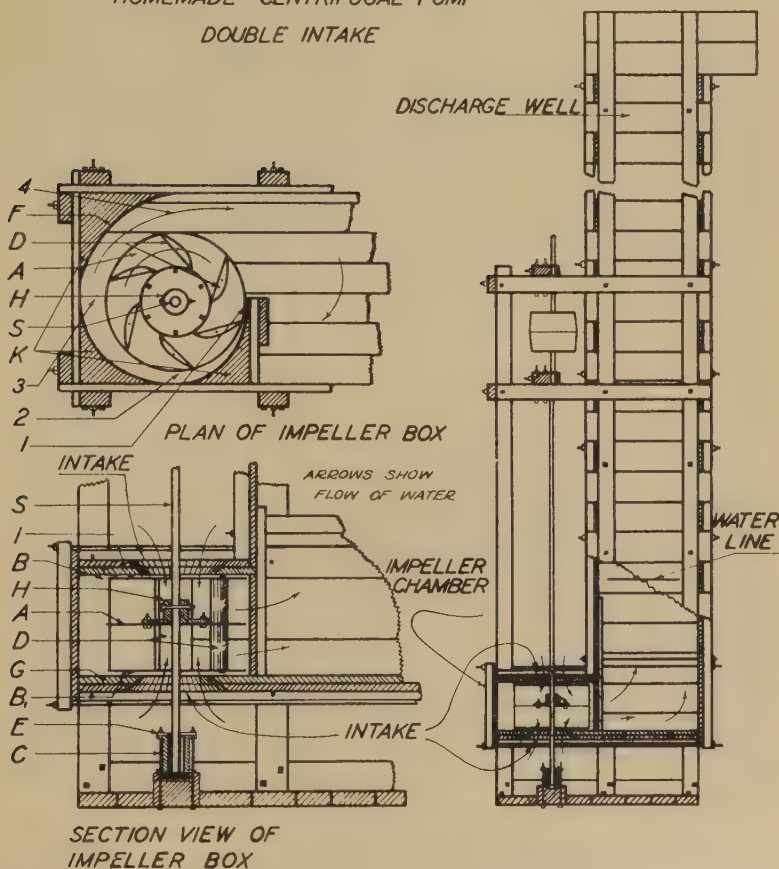
Feeds on the market sometimes contain weed seeds which may be left in the manure from the animals fed such feed. Such

weed seed, if viable, may become a menace in pastures or in fields fertilized with such manure. To guard against this, the laboratory is equipped to make tests of feed stuffs to determine the kinds of viable seeds which are present. This is done by mixing the feed to be tested with sterile soil and placing it under good growing conditions for about two months. At the end of this time, the soil is examined for plants and those found are identified. Manure which is to be used for top-dressing pastures and meadows can also be tested in this same manner.



GRASS SEEDS (MAGNIFIED 4.5 DIAMETERS). THE TIMOTHY SHOWS ONE SEED IN THE HULL AND TWO WITH HULLS REMOVED. THE OTHER SEEDS SHOW TWO VIEWS OF EACH IN THE HULLS AND ONE WITH HULLS REMOVED. A, TIMOTHY; B, BROME GRASS; C, SLENDER WHEATGRASS; D, CRESTED WHEATGRASS

HOMEMADE CENTRIFUGAL PUMP DOUBLE INTAKE



SECTIONAL VIEW OF A DOUBLE INTAKE HOMEMADE CENTRIFUGAL PUMP

A, center impeller disk; B and B¹ outside disks, 2 required; C, thrust bearing; D, impeller blades, set of 12; E, grease retainer, made of old rubber belt; F, spiral; G, lower intake plate; H, hub; I, upper intake plate; J, steady bearing for shaft over 4 feet long; K, wooden blocks to hold spiral, F, in place; 1, 2, 3, and 4, clearance at quarter points

ENGINEERING SERVICE TO THE LIVESTOCK INDUSTRY

To increase the area that may be irrigated, water can often be pumped to higher levels if the cost of the equipment and its operating expense are not excessive. The Engineering Department has been studying water wheels of many types for lifting water, and studying the results from various makes of pumps. A low lift centrifugal pump has been devised which may be constructed at small cost and yet is quite efficient in lifting water 10 or 12 feet. Often several acres used to grow feed or a garden can be irrigated through the use of such a pump. A bulletin has been prepared describing this pump.

Barns and corrals for protecting and handling stock, feed racks, dipping vats, hay handling equipment, fences, gates, and practically all types of equipment used in caring for livestock are designed and made by mechanics and engineers. In the development of such equipment agricultural engineers have carried on investigations and experiments to determine the forms and types that will give the best results under the varying conditions found on ranches. The Montana Station has available much information about these farm conveniences.

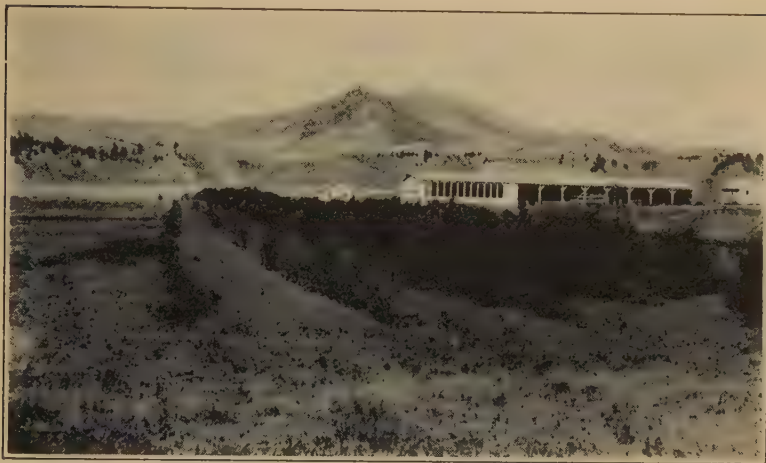
This department has made extensive studies on the measurement of hay stacks and has figured out the relationship between the measurements and the weight of hay in the stack. The conclusions drawn will be valuable to the ranchman if he has to buy hay where scales are not available. A bulletin describing the results of this study is available.

ADDING TO THE ATTRACTIVENESS AND COMFORT OF THE RANCH HOME

SHELTER BELTS

Trees and shrubs in shelter belt plantings in Montana have the ability to establish themselves and make growth under adverse conditions. That is the record of the experimental shelter belt at the Fort Ellis Farm, Bozeman. This belt was planted in 1931 and has had four dry seasons to combat.

Caragana and Chinese elm are the deciduous trees used. No replacements of these two species have been made though the tops kill back some seasons. The stand of Caragana exceeds 90 per cent and Chinese elm survival is in excess of 85 per cent. The Chinese elm has in some instances reached a height of 8 to



TWO VIEWS OF SHELTER BELT AT THE FORT ELLIS FARM, BOZEMAN

9 feet and very few trees are less than 6 feet. Colorado blue spruce and Scotch pine were planted in the inside rows. Only one Scotch pine lived, while 60 per cent of the stand of blue spruce survived. Replacements have been made, using blue spruce entirely as it is one of the easiest evergreens to establish.

This 5-year old shelter belt already has value. It has improved the appearance of the farm and in addition has trapped much snow and prevented its piling up in the feed yard and around buildings.

SMALL FRUITS

A planting of Latham raspberries in the experimental gardens at Bozeman has, year after year, produced a good crop of fruit. Home gardens in Montana can maintain similar plantings and supply the home with these berries. Winter protection is the secret of success. No variety tested at Bozeman has had sufficient hardiness to meet winter conditions without killing back the canes and injuring the buds in at least three out of four years unless the vines are protected. This winter protection has consisted of bending the canes to the ground and covering with earth. It is not a difficult job. A protected 50 foot row has been averaging 60 pint boxes. As low a figure as 15 cents a box means a return of \$9 for this row. Two hours of labor will cover the row of canes.

VEGETABLES

The vegetable garden, on any farm in Montana, contributes materially to the farm living and the farm income. Vegetables constitute a considerable portion of the menu. By the time a grower at a distance is paid for growing this crop, the railroad for transporting it, and the various commercial houses and stores for handling it, the consumer in this state is paying a fairly good price for his vegetables. When a garden is lacking however, the average family is very dependent upon the tin can product. While it is a reasonably good substitute, it is an expensive one and is not as desirable as fresh vegetables. Unfortunately, when a garden is not on the place, many families have far too few fresh vegetables and must depend on meats and potatoes.

It is unnecessary to tell how to prepare the ground and to plant and care for garden crops in the usual way. We are presenting, instead, some special information which leads to better crops, better grade, earlier maturity, and better keeping quality for many of the different vegetables.

On dry land, the garden should be grown on fallowed ground with the storage of all moisture possible. Sometimes a wind-break on the side of the garden from which the prevailing wind comes will accumulate snow to wet the ground and in addition provide some protection from high winds. As only half of the garden area is cropped each year the plants should be given lots



BUILDINGS AT THE HORTICULTURAL BRANCH STATION NEAR
CORVALLIS, WHERE THE WORK IS DEVOTED EXCLUSIVELY TO
FRUIT AND VEGETABLES

of space on the ground. Ample land will be needed but the crop will be better and more dependable.

In our northern climate with short seasons, early maturing varieties are very desirable. The application of a phosphate fertilizer will be helpful in this direction. It will moreover greatly improve the quality of the vegetables.

If the garden can be irrigated, larger, more dependable, and better quality vegetables will be obtained. Much less land will be needed to provide the home supply, but more frequent fertilization will be required.

Pruning and staking tomato vines will hasten the securing of ripe fruit by fully three weeks in the high valleys. At Bozeman tomatoes so handled will generally ripen in early August. Staking is more important than pruning.

To get early and good yields of certain kinds of vegetables, and to take full advantage of our short growing season, vegetable seeds should be planted in hotbeds or in boxes which can be kept away from cold and frost. This gives the plants a good start before they are transplanted to the garden. A good rich soil with some well rotted manure and a little phosphate fertilizer gives the best plants. The temperatures at which they are grown is important. Celery plants should be kept at 60° F. or above; tomatoes require a moderate temperature, as do cauliflower, cabbage and head lettuce; onion plants should be grown at about 50° F. Plants, if 40 days old before transplanting will produce an earlier crop but if planted at 25 to 30 days old they will produce a larger crop of better quality.

USE OF LIVESTOCK PRODUCTS IN THE HOME

The work of the Home Economics Department is rather indirectly related to the development of the livestock industry in Montana. Instead of being actively interested in the problems of livestock production this department is more concerned with livestock products that are used in the homes throughout the state. These include such items as meats, dairy products, fats, some textile fibers, and leathers. However, any experimental work on these materials, in relation to their use in the home, may have a direct effect on the livestock industry.

Of late there has been a growing demand from homemakers for meats of better quality. As previous investigations have already shown that meat quality may be influenced by breed, feed, degree of finish, and care after slaughtering, it is apparent that these items need further consideration by the livestock industry if they are to meet the demands of the consumer.

Some experimental work along this line has been carried on at this station for several years through the cooperation of the Animal Husbandry and Home Economics departments. Lambs were fed on rations containing varied concentrates, then the meat was properly aged, roasted, and judged as to its quality and palatability. The results of these feeding trials showed that the use of wheat screenings as lamb feed should not be encouraged as they produced a flabby quality and peculiar flavor in the meat. When grains, such as oats, barley, and wheat were fed, the oat-fed lamb was slightly superior in quality, juiciness, and general palatability. The addition of either wet or dry beet pulp to a ration of oats and alfalfa hay produced lamb meat that was very desirable in quality and palatability.

Similar palatability studies have been started using beef roasts obtained from cattle fed on native range grass, brome grass, or crested wheat grass. Such studies will eventually show whether these grazing feeds produce meats of equal quality or whether certain ones are superior as feeds. Grass-fed and grain-fed beef may also be compared.

As this work is continued, it will also include investigations regarding the quality and palatability of other livestock products—milk, butter, cheese, fats—as they are affected by production.

A problem that always confronts homemakers involves the efficient use of livestock products. These are usually the more expensive items in the family's food and it is essential that they should be properly and economically used or prepared to give an appetizing dish and thus prevent waste. They are also very nutritious foods, and for this reason, the methods used in their preparation should be carefully selected so there may be no loss in food value. The Home Economics Department is particularly interested in this type of investigation and is already starting some work along this line, giving special attention to the vitamin content of the foods.

Another question closely related to the use of livestock products is that of the preservation of these materials by safe and economical methods. The home canning and curing of excess supplies of meat and the packing of butter for future use often play an important part in determining the family's food supply and should have some experimental consideration. Some attention has already been given to safe methods of meat preservation. Directions and time tables for canning meats in the pressure cooker are presented in Montana Station Circular No. 147 (1935), "Home Canning by Safe Methods."

Other livestock products, such as the textile fiber, wool, and the skins or leathers from the various animals, deserve more attention than has been given to them from an experimental standpoint. It is anticipated that in future studies of home problems some of these materials may be included.

THE STORY OF THE WEATHER FOR 1935

An annual and a monthly summary gives a general idea of weather conditions during 1935. A more detailed study is possible if the year is divided into three seasons—winter, from November to the following March, inclusive; the growing season, April to August, inclusive; and the autumn months, September and October.

The winter months were not characterized by any unusual temperatures but the 1935 precipitation was 1.48 inches above normal; the precipitation of 3.24 inches in March, which fell as snow, was responsible for this extra supply of moisture. A complete picture of the storage of water for 1935 can not be made without taking into account the low precipitation of 0.33 inch that fell during the months of November and December of 1934. However, the early runoff from the mountains was retarded by a subnormal temperature for April and May, which was an aid to later irrigation needs.

The growing months started with a cold April and a precipitation slightly above normal. The temperature for the remaining growing season was above normal, a condition which was accompanied by a subnormal precipitation of 2.31 inches while the evaporation was nearly 3 inches above normal. This called for an extra supply of moisture in the form of irrigation to sus-

tain normal growth of grains and forage crops. August was unusually hot and dry and this favored the early maturity of crops.

The autumn months continued hot and dry until the 12th of October when the dry spell was broken by a total precipitation of 1.99 inches between the 12th and 15th. Climatic conditions were ideal for harvesting and threshing, but the ground was too dry to germinate winter wheat until after the October rains. The precipitation for the month of October was 0.83 inch above normal.

There was no freezing weather in September and October continued warm until the 22nd and 23rd when the thermometer dropped to 19°F. and 18°F., respectively. This chilly spell was followed by warmer weather and on the 27th the temperature rose to 67°F. and on the 28th to 68°F. Leaves were still on the trees and shrubs and to all appearances had not been injured. Life processes were still active until October 29th when the thermometer dropped to 57°F. and to 10° below zero on the 30th, which was the coldest day on record for October. This sudden change took place when metabolism was still active within the trees and resulted in severe injury if not death to fruit trees and shrubbery. This sudden change was not so great as that in December, 1924, when the temperature dropped from 58°F. on the 14th to 9° below zero on the 15th with a still further drop to 23° below on the 16th. This sudden change in temperature occurred, however, after the fruit trees were dormant; yet in the western part of the state with a similar drop in temperature severe injury occurred. The sudden drop in temperature in October, 1935, and the condition of the trees at that time, leads us to fear that more severe damage will be done than occurred in 1924.

WEATHER SUMMARY FOR 1935
BOZEMAN

Highest temperature	95°, July 27
Lowest temperature	-35°, Jan. 20
Greatest range for year	130°
Highest monthly mean	66.6°, July
Lowest monthly mean	23.0°, January
Highest daily mean	79.0°, July 27
Lowest daily mean	-26.5°, Jan. 20
Mean temperature for year	40.9°
Greatest total precipitation for 1 month	3.24 inches, March
Least total precipitation for 1 month	0.15 inch, September
Total rainfall	15.46 inches
First killing frost	September 27
Last killing frost	May 11
Number of clear days in year	102
Number of partly cloudy days in year	208
Number of cloudy days in year	55
Days with 0.01 inch or more precipitation	100
Total evaporation from April to October, incl.	41.718 inches

PUBLICATIONS

The publications of the Experiment Station for the past year included thirteen bulletins, two circulars, and fifteen technical papers. The bulletins and circulars were printed in editions ranging from 3,000 to 10,000 copies. With the annual report they make a volume of 563 pages.

The bulletins report the results of investigations carried on by the station staff. Many of the more technical reports are published in scientific journals. Since the last annual report the following publications have been issued.

BULLETINS

Superheating as a control for Cereal-Mill Insects. J. H. Pepper and A. L. Strand. (Bul. 297, 26 pages, 3,000 copies.)

Montana County Organization, Services, and Costs. Roland R. Renne. (Bul. 298, 119 pages, 4,000 copies.)

Selection, Care, and Wearing Qualities of Women's Silk Hosiery. Jessie E. Richardson and Vivian Baker. (Bul. 299, 75 pages, 3,000 copies.)

Potato Diseases in Montana. H. E. Morris and Paul A. Young. (Bul. 300, 49 pages, 5,000 copies.)

Conservation of Water by Means of Storage Reservoirs, Diversion Dams, Contour Dikes and Ditches. O. W. Monson. (Bul. 301, 48 pages, 4,000 copies.)

The Economics of Range Sheep Production in Montana. M. H. Sanderson and Louis Vinke. (Bul. 302, 55 pages, 5,000 copies.)

Rye as a Grain Feed for Dairy Cows. J. O. Tretsvén. (Bul. 303, 11 pages, 3,000 copies.)

Skim Milk Foam: Its Effect on Dairy Calves. J. O. Tretsvén. (Bul. 304, 7 pages, 3,000 copies.)

Comparison of Some Methods of Growing Onions. C. C. Starring. (Bul. 305, 11 pages, 3,000 copies.)

Readjusting Montana's Agriculture. I, The Need and Basis for Readjustment. Roland R. Renne. (Bul. 306, 24 pages, 9,000 copies.)

Financing Montana Schools. Roland R. Renne. (Bul. 307, 16 pages, 9,000 copies.)

Readjusting Montana's Agriculture. II, Montana Farm Prices. P. L. Slagsvold. (Bul. 308, 16 pages, 7,000 copies.)

Readjusting Montana's Agriculture. III, Population Resources and Prospects. Roland R. Renne and Carl F. Kraenzel. (Bul. 309, 19 pages, 7,000 copies.)

CIRCULARS

Cold Weather and Its Effect on Injurious Insects. G. Allen Mail. (Cir. 146, 8 pages, 4,000 copies.)

Home Canning by Safe Methods. Jessie E. Richardson and Helen L. Mayfield. (Cir. 147, 19 pages, 10,000 copies.)

ANNUAL REPORT

Service to Montana's Livestock Industry. F. B. Linfield. (Forty-Second Annual Report, 60 pages, 3,000 copies.)

TECHNICAL PAPERS

Ladak Alfalfa Investigations in Montana. M. A. Bell. Paper read at Western Section of International Crop Improvement Association, Aug., 1935. (Jour. Ser. No. 61.)

A new Legume in Montana. J. R. Green and H. E. Morris. Jour. Am. Soc. Agronomy, July, 1935. (Jour. Ser. No. 49.)

The Grain Bug in Montana. G. Allen Mail. Jour. Economic Entomology, Dec., 1935. (Jour. Ser. No. 63.)

Electrokinetic Properties of Proteins III. The Role of Electrical Forces in the Adsorption of Gliadin at a Glass-Liquid Interface. William McK. Martin. Jour. Physical Chemistry, Feb., 1935. (Jour. Ser. No. 43.)

Tests of Farm Tractors Under Field Conditions. H. E. Murdock. Paper read at International Congress of Rural Engineers, Sept., 1935. (Jour. Ser. No. 54.)

The Importance of Surface Temperatures in Heat Sterilization. J. H. Pepper and A. L. Strand. Jour. Economic Entomology, Feb., 1935. (Jour. Ser. No. 41.)

Qualifications of Montana County Officers. Roland R. Renne. National Municipal Review, Aug., 1935. (Jour. Ser. No. 54.)

Significance of the Ownership Pattern to Land Use Planning. Roland R. Renne. Jour. Farm Economics, Aug., 1935. (Jour. Ser. No. 55.)

Pea Vine Silage as a Feed for Dairy Cattle. J. O. Tretsvén. Jour. Dairy Science (Abst.), July, 1935. (Jour. Ser. No. 57.)

Skim Milk Foam and Its Effect on Dairy Calves. J. O. Tretsvén. Proceedings of Western Division of American Dairy Scientists Assn. (Jour. Ser. No. 62.)

Bang's Disease in Bison and Elk in the Yellowstone National Park and on the National Bison Range. E. A. Tunnicliff and H. Marsh. Jour. Am. Veterinary Medical Assn., June, 1935. (Jour. Ser. No. 47.)

A Whole-Blood Field Agglutination Test for Infectious Abortion in Range Cattle. Howard Welch and H. Marsh. Jour. Am. Veterinary Medical Assn., April, 1935. (Jour. Ser. No. 45.)

Decane Ring Spot of Apple Leaves and Symptoms of Decane Injury in Apple, Potato, and Onion. Paul A. Young. Am. Jour. Botany, July, 1935. (Jour. Ser. No. 38.)

Oil-Mass Theory of Petroleum-Oil Penetration Into Protoplasm. Paul A. Young. Am. Jour. Botany, Jan., 1935. (Jour. Ser. No. 32.)

Distribution and Effect of Petroleum Oils and Kerosenes in Potato, Cucumber, Turnip, Barley, and Onion. Paul A. Young. Jour. Agr. Research, Nov., 1935. (Jour. Ser. No. 52.)

THE STATION STAFF

The Experiment Station has been fortunate in that no member of the staff occupying a major position resigned during the past year. M. L. Wilson, Head of the Agricultural Economics Department continues on leave as Assistant Secretary in the Federal Department of Agriculture. Elmer A. Starch of the same department has been on leave in federal work for most of the year.

The additions to the Station staff have been C. F. Kraenzel, assistant agricultural economist; O. L. Mimms, assistant in the Department of Agricultural Economics; F. K. Nunns, assistant in the Agronomy Department; Chester S. Funk, assistant in the Chemistry Department; and J. H. Pepper, assistant in the Entomology Department. Mr. Cyril Evans, assistant in the Chemistry Department, resigned in the latter part of the year.

STATION FINANCES

The state legislature of 1933 reduced the state appropriations to the Agricultural Experiment Station and the Branch Stations approximately 36 per cent below that made in 1931. The legislature of 1935 restored about one-eighth of this cut, or an increase over the 1933 appropriations of \$4,483, of which \$2,183 was

for the Home Station at Bozeman and \$2,300 for the Branch Stations and for services over the state.

Early in the fiscal year, 1935-36, the passage of the Bankhead Jones Bill by the United States Congress made available to the Station an additional \$3,875.79. A like sum will be added during each of the four succeeding years, provided the state maintains the present rural population. The giving of this amount, however, depends first on its use for approved agricultural research projects and second on its being considered by the state as an addition to the resources of the research work of the Experiment Station, and in no wise considered as a substitute for present or future appropriations from the state for research work.

A substantial but temporary addition to the resources and to the work of the Experiment Station has been the allotment from the Federal Emergency Relief Administration, the Works Progress Administration, and other federal funds, for special studies growing out of the relief problems occasioned by the depression and the extreme drought conditions in the state. These funds have brought an increased load of work and very much enlarged the responsibilities of the workers in several departments of the Experiment Station. The opportunity has been used to more fully study the land and water resources of the state and obtain a more complete picture of the economic, financial and social problems of our rural areas.

FINANCIAL SUMMARY

EXPENDITURES OF THE MONTANA AGRICULTURAL EXPERIMENT STATION
FOR THE YEAR ENDING JUNE 30, 1935

	Hatch fund	Adams fund	Purnell fund	State appropriations and miscel- laneous*
Salaries	\$ 7,874.27	\$ 9,504.88	\$28,914.91	\$ 58,070.80
Labor	905.88	3,132.97	17,148.28	18,379.34
Stationery and office	—	—	188.00	1,344.44
Scientific, consumable				
Feeding stuffs	2,699.99	11.20	621.71	13,071.56
Fertilizers	—	3.75	144.74	28.32
Sundry	688.83	191.02	923.78	16,817.13
Communication service	332.08	10.81	178.43	1,389.35
Travel expenses	210.42	1,109.95	3,498.25	3,842.56
Transportation of things	11.40	13.85	213.13	1,003.58
Publications	1,460.72	—	1,471.31	2,752.88
Heat, light, water, power	—	49.44	364.14	3,890.75
Contingent expenses	—	—	24.46	91.46
Furniture, furnishings, fixtures	150.57	29.75	220.43	883.69
Library	414.47	12.37	64.37	63.82
Scientific equipment	122.46	280.80	2,313.92	237.93
Tools, machinery, appliances	45.75	149.81	1,448.90	5,425.84
Livestock	—	—	500.00	914.00
Buildings and land	32.63	—	252.42	1,788.64
Total	15,000.00	15,000.00	60,000.00	130,640.59

*This fund includes the following:

State appropriations for Home Station	\$47,817.00
For Grain Laboratory and Branch Stations	24,700.00
Income from sales	58,123.59

POZIMAN CHRONICLE PRINT 